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Toward a wiser projectification: Macroeconomic effects of firm-level project work

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Abstract

Several studies have investigated projectification and its effects at the firm level, but the macroeconomic implications of project work have scarcely been considered. This paper analyzes the macroeconomic effects of firm-level projectification. We study the interlinkages between different sectors by extending standard input-output modeling and analyze the static and dynamic effects of projectification. The results indicate that projectification can have positive macroeconomic implications for production/innovativeness, employment and income that differ across economic sectors, but projectification can also have negative impacts. As a major implication, the use of temporary forms of organizing cannot be recommended without reproach but depends on the economic sector and sectoral interdependencies.

Keywords: Innovativeness; Projectification; Project work; Temporary organization; Income effects; Employment effects

1. Introduction

20 years ago, the term ‘projectification’ was introduced to describe an important change in organizational structures and processes. Using the case of the car manufacturer Renault, Midler (1995) portrayed how a quantitative increase in project work accompanied by qualitative changes in the functioning of new product development resulted in increased primacy of project work throughout the company. Ekstedt et al. (1999) and Powell (2001) placed projectification in a larger context to describe the more general transformation of firms from industrial to post- (or neo-) industrial organizations. This context includes related developments such as globalization, servitization, knowledgeization, and digitization (Lundin et al., 2015).

Despite some criticism of the actual extent of projectification and its degree of novelty (Hodgson, 2004; Cicmil et al., 2009), the literature generally agrees on the positive aspects and the increasing prevalence of project work. Projects as temporary organizations contribute to making firms more flexible, innovative and capable of dealing with unique, risky and complex tasks (Hobday, 2000; Keegan and Turner, 2002; Whitley, 2006; Bakker, 2010; Hanisch and Wald, 2014; Lundin et al., 2015; Spanuth and Wald, 2017; Manning, 2017). At the firm level, projectification itself constitutes an organizational innovation. Research has shown that organizational innovation has positive effects on firm performance (Sapprasert and Clausen, 2012) and enhances process and product innovation (Camisón and Vilar-López, 2014; Cozzarin, 2017).

Choosing a project form of organization over a permanent form is an economic choice made by the management of each individual firm. Accordingly, the positive (or negative) effects of project work will first become visible at the firm level, but the effects of project work at the firm level can be supposed to sum at the industry level and sector level. Ceteris paribus, industries with a higher share of project work can be supposed to be more

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productive, profitable and innovative than industries with a lower share of project work. Moreover, higher productivity and innovativeness of a specific sector spill over to other sectors of the economy. Although this logic of aggregation is intuitively appealing, empirical research has not considered *meso*-level (industries and sectors) and macro-level (economy) effects of projectification in a systematic way (Wald et al., 2015; Schoper et al., 2018). A better understanding of the effects of projectification on these meso and macro levels is an indispensable complement to firm-level studies and a response to repeated claims that projectification is no longer limited to traditional project-oriented industries like construction or filmmaking but is prevalent throughout the entire economy (Engwall, 2003; Bechky, 2006; Whitley, 2006; Hodgson, 2004; Hodgson and Cicmil, 2007) and in the public sector (Godenhjelm et al., 2015). The study of the macroeconomic consequences of projectification is an important prerequisite for further empirical research in response to conceptual work arguing that projectification not only has important economic impacts but also significantly affects the entire society (Lundin and Söderholm, 1998; Lundin et al., 2015; Jensen et al., 2016). Finally, knowledge of the macro-level effects of projectification can inform policymakers seeking to enhance the innovation capacity of economies and industries to secure competitiveness and employment.

The present study seeks to generate knowledge on the effects of projectification at the level of the entire economy and of economic sectors. We build on the data of Wald et al. (2015), who measured the share of project work in the German economy and develop a model that represents the inter-sector relationships in the economy. Extending standard input-output modeling (Leontief, 1986), we differentiate each sector into project and non-project work subsectors and model inter-sectoral linkages resulting from cross-sectional demand and supply. We analyze the production effects (innovativeness), employment effects and income effects of projectification.

The remainder of this paper is structured as follows. In the theoretical part, we first elaborate the characteristics of projects as temporary organizations and discuss the measurement of projectification before introducing traditional input-output modeling and our extension of it. In the empirical part, we apply our model to analyze different effects of projectification. This analysis is followed by a discussion of the results and implications for future research.

2. Projects as temporary organizations

2.1. Characteristics of project work

There is consensus in the literature that all projects are temporary organizations and that the most prevalent form of temporary organization is the project (Bakker, 2010). Therefore, the terms project and temporary organization can be used as synonyms, although project often refers to the more technical aspects of project management, whereas temporary organization indicates a broader and theoretically richer perspective in organization studies (Bakker et al., 2016; Nuhn et al., 2018).

The literature has identified several characteristics that differentiate temporary organizations from regular, permanent organizations (Lundin and Söderholm, 1995; Hobday, 2000; Bakker, 2010; Lundin et al., 2015). These characteristics can be grouped into five main categories (Hanisch and Wald, 2014): duration, nature of the tasks, hierarchy, team composition, and coordination. Fig. 1 opposes temporary organizations (TOs) and permanent organizations (POs) based on these categories. The left side of Fig. 1 shows the characteristics of a "pure" TO, e.g., a change project. The right side of Fig. 1 depicts the characteristics of a "pure" PO, e.g., the procurement department of a firm. In reality, there can be deviations from these pure types; i.e. TOs may exhibit elements of POs, and vice versa (Hanisch and Wald, 2014).

On the one hand, the characteristics of TOs require a specific management approach (Müller et al., 2012), as reflected by the comprehensive repertoire of available project management standards, methods, and techniques (IPMA, 2015; PMI, 2013; Prince2, 2009). On the other hand, the characteristics of TOs are supposed to make projects a suitable form of organizing to deal with complex and knowledge-intensive tasks, generate innovations, and enhance organizational flexibility (Hodgson, 2004; Whitley, 2006; Lundin et al., 2015). For instance, the focus on a unique, new task by a flexibly (temporary) composed team supports the generation of innovation (Keegan and Turner, 2002). Likewise, project teams composed of heterogenous

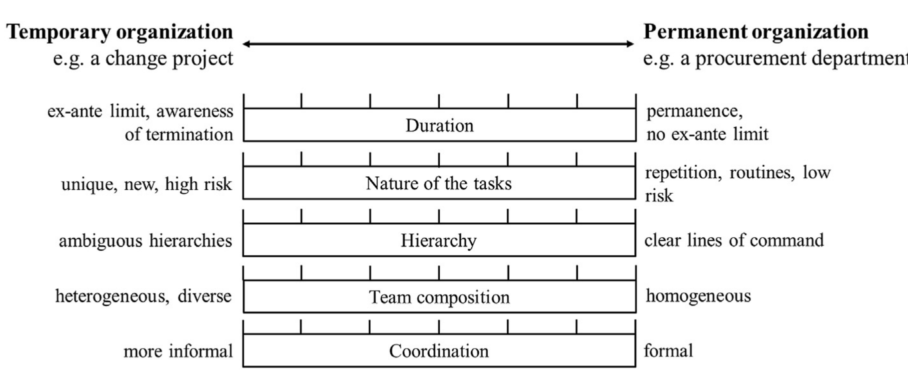

Fig. 1. Temporary and permanent organizations.

experts with different disciplinary backgrounds are appropriate for knowledge-intensive tasks (Blindenbach-Driessen and van den Ende, 2006). A heterogeneous team composition combined with more informal, role-based coordination also renders projects “complexity resistant” and thus makes projects an adequate organizational form for highly complex tasks (Hobday, 2000; Bechky, 2006; Hanisch and Wald, 2014).

Shifting from non-project work to project work constitutes an organizational innovation that includes the adoption of new internal processes, structures and management practices (Pauget and Wald, 2018). Projectification has been studied extensively at the firm level in empirical research. At aggregate levels, such as economic sectors, research remains relatively conceptual (Lundin and Söderholm, 1998). Ekstedt et al. (1999) described an increasing project prevalence leading to project-intensive economies. This development was attributed to a fundamental change in economic organization characterized as “neoindustrial organizing”. Likewise, Powell (2001) portrayed projects as a new architecture of work that will increasingly replace “old” systems of organizing work in more permanent forms. Many authors have pointed out that projectification is no longer confined to typical, project-based industries but can be observed in all sectors of the economy (Engwall, 2003; Bechky, 2006; Whitley, 2006; Hodgson and Cicmil, 2007; Lundin et al., 2015). The temporary and transitory character of projects has even been ascribed to the level of society, presuming that projects are a central discursive theme in the social construction of contemporary society (Packendorff and Lindgren, 2014; Lundin et al., 2015). From this perspective, it is only one small step to proclaiming “the projectification of everything” (Jensen et al., 2016: 21). In this paper, we adopt a narrower view of projectification by limiting it to economic activity.

2.2. Measuring projectification

Much of the empirical evidence for increasing projectification has been provided by vivid case studies (e.g. Midler, 1995) or research focusing on typical project-based industries, such as filmmaking (Bechky, 2006) or the music industry (Sedita, 2008). There have been few attempts to provide more comprehensive data on the degree of projectification (Whittington et al., 1999; PWC, 2004; Scranton, 2014). Only Wald et al. (2015) have delivered a precise picture of projectification that quantifies the share of project work in its entirety, including all sectors, organization types and project types. We therefore build on the data presented by Wald et al. (2015) and Schoper et al. (2018), who measured the projectification of the German economy by using the share of project work to total working hours as an input-oriented measure. They found that the projectification of the German economy was 34.7% in 2013; i.e. 34.7% of all working hours in the entire economy were part of projects. Table 1 provides an overview of the projectification of the German economy that differentiates 10 economic sectors.

As shown in Table 1, the degree of projectification varies among sectors. It is highest for construction and corporate service providers (e.g. consultants, law firms) and lowest for agriculture. However, even in a supposedly non-projectified area like the public sector, 17.8% of all work is carried out in projects.

Table 1
Projectification of the German economy in 2013 (Source: Wald et al., 2015: 29).

NACE code	Sector	Share of project work 2013	Share on GVA 2013
A	Agriculture, forestry and fishing	4.0%	0.9%
B-E	Manufacturing industry	41.9%	26.1%
F	Construction	80.0%	4.6%
G-I	Retail / transport / hospitality / tourism	42.0%	15.6%
J	Information and communication	37.7%	4.7%
K	Financial services & insurance	23.0%	4.1%
L	Real estate	2.0%	11.1%
M-N	Corporate service providers	60.0%	10.7%
O-Q	Public sector, education, health	17.8%	18.1%
S	Other service providers	23.0%	4.1%
	Total	34.7%	100.00%

3. Macroeconomic effects of projectification

To analyze the macroeconomic effects of projectification, we consider project work (P) and non-project work (NP) as two different subsectors that apply different production technologies to produce output. In a general equilibrium framework with perfect factor and commodity markets, the optimal total production share of each subsector corresponds to the marginal factor productivities defined by the specific subsector production functions. However, empirically, the shares of project work and non-project work are determined by management decisions within firms. Therefore, empirically observed subsector shares do not generally correspond to theoretically optimal shares. In particular, the allocation of capital across these subsectors, at least in the short run, does not follow a perfect market allocation. Analyzing the economic impact of shifting activities from NP to P in a general equilibrium framework corresponds to a shift of quasi-fixed capital stock from the NP to P subsector. Capturing the pure structural effect of this shift implies that the aggregated capital stock in both subsectors is held constant.

What is the structural impact of such a shift? First, the shift implies that the production of the NP subsector decreases while the production of the P subsector increases and, in turn, that the factor and intermediate input demand decreases for the NP subsector but increases for the P subsector. As the P and NP subsectors have different technologies, the net effects on the total factor and input demands of both subsectors are not zero. However, the total effect of this shift goes beyond these direct effects. Higher net demand for intermediate inputs implies, ceteris paribus, higher production of these specific commodities; conversely, a net decrease in intermediate demand implies lower production of these commodities. Thus, projectification in a specific sector corresponds to a change in production in all economic sectors.

Analogous to the original shift in production in the P and NP subsectors, the indirectly induced production effects in other sectors continue to spill over to all other sectors, thus inducing a second round of production and intermediate demand effects, which induces a third round and so forth. In total, these rounds establish the indirect effect of projectification. The direct and indirect effects can be measured by applying general equilibrium models.

3.1. Measuring the macroeconomic effects of Projectification

Different general equilibrium approaches have been used to measure the economic impact of structural changes like projectification. Prominent approaches are input-output models (Leontief, 1941, 1986) and computable general equilibrium models (CGE) (Shaven and Wollley, 1982). Although the derived economic effects depend on the specific model assumptions regarding the response of the economic system, for both approaches, economic impacts are crucially determined by multiplier effects resulting from the intermediate demand interlinkages between sectors and between subsectors.

It is fair to conclude that CGE models would be theoretically more suitable than IO models for analyzing the impact of a shift from the NP to P subsector, especially since CGE models make less restrictive assumptions than IO models (Dixon and Parmenter, 1996; Shoven and Whalley, 1992). However, compared to IO models, CGE models are also more complex and data demanding. Accordingly, many empirical studies still use IO multipliers to analyze the economic impacts of structural changes, i.e. economic growth of an existing sector or entry of a new economic sector (The World Bank, 2015). These studies justify the application of IO multipliers as they can be interpreted as local approximations corresponding to CGE multipliers (The World Bank, 2015). Hence, given the limited availability of empirical data, we apply an IO model approach as a first attempt to identify macroeconomic effects of projectification.

3.2. Standard input-output analysis

Input-output analysis (IOA) was originally developed by Leontief (1941, 1986) for modeling interdependencies among the sectors of an economy. In 1973, Leontief won a Nobel Prize in economics for his work on IOA, and his model has found many applications in fields such as environmental economics (Kucukvar et al., 2014), sectoral economics (Chang et al., 2014), and energy economics (Markaki et al., 2013).

An input-output model (IOM) treats all sectors of an economy as output-generating and input-receiving entities. The output (products and services) of each sector is considered a commodity that is used as input by other sectors, is demanded for final consumption, leads to gross capital formation, or is exported to other countries. Table 2 provides a simple example of an input-output economy including three sectors. The rows in the table represent the output of each sector in monetary terms, and the columns represent the input of each sector. As an example, Table 2 shows that the total output of sector II is 350, of which 33.1 is used as input for sector I, 48.2 is input for sector II itself, 77.8 is input for sector III, 81.4 is used for final consumption, 41.8 contributes to gross capital formation, and 67.7 is exports. The interdependencies among the sectors can thus be found in the cells of the table where the rows and columns of the sectors intersect; i.e. the row sector delivers to the column sector.

Accordingly, each column comprises intermediate inputs delivered by economic sectors and primary inputs of production factors (labor and capital captured by value-added in Table 2). The column sum corresponds to the total production value of the corresponding column sector. By contrast, each row comprises outputs delivered by a sector, i.e. intermediate outputs delivered to economic sectors as well as outputs delivered for final demand. The latter is subdivided into final consumption of private and public households, investment goods (capital formation) and exports. The cost structure of a sector is obtained by normalizing the cell values in a column by dividing each cell value by the column sum. Let a_{ij} denote the input coefficient of sector i with regard to sector j. This coefficient represents the share of intermediate inputs delivered by sector i to sector j in the total production value of sector j. Accordingly, let b_{fj} denote the input coefficient of factor f with regard to sector j. This coefficient represents the share of factor cost in the total production value of sector j. Assuming for each sector a Leontief production function with the input coefficients (a_{ij}, b_{fj}) delivers the input-output theory (Leontief, 1941, 1986).

The original Leontief open input-output system is entirely driven by the final demand matrix consisting of private and public consumption, investment, changes in stocks and export (Leontief, 1941, 1986). The final demand determines total outputs, intermediate inputs and primary inputs through a set of

Table 2
Example input-output table (Source: adopted in modified form from Eurostat, 2008).

Industry	Industry			Final Uses			
	Sector I	Sector II	Sector III	Final consumption	Gross capital formation	Exports	Total output
Sector I	28.50	50.00	120.00	61.50	25.90	14.10	300.00
Sector II	33.10	48.20	77.80	81.40	41.80	67.70	350.00
Sector III	89.50	119.30	169.70	78.50	15.30	27.70	500.00
Value added	82.70	67.20	79.90				229.80
Imports	66.20	65.30	52.60				184.10
Output	300.00	350.00	500.00	221.40	83.00	109.50	

technical coefficients. The demand-side analysis of an IOM focuses mainly on how the output level responds to the exogenous change in aggregate demand in the economy. One of the assumptions underlying a demand-driven IOM is the existence of unused capacity and an elastic factor supply that can meet input requirements instantaneously to produce the output. Thus, a demand-driven IOM is not suitable for analyses that incorporate sectors with supply constraints.

In the Leontief system, demand equals supply for goods and factor services, and the cost of production (supply price) equals the demand price for goods. Value-added comprises the value of factor items: wages, profits and other value added, taxes, subsidies and imports for production (Leontief, 1986). In Leontief's (1941, 1986) empirical input-output table, quantities are expressed in monetary units, and all prices are set to one.

It follows from Leontief's input-output theory that the impact of an exogenous demand shock ΔE on the production of the total economy can be calculated as follows:

$$\Delta X = (I-A)^{-1}\Delta E \tag{1}$$

here, ΔX is a column vector (n × 1) of total output changes in monetary terms; A is the matrix (n × n) of directinput coefficients in monetary terms; ΔE is a column vector (n × 1) of changes in final demand in monetary terms. By using (1), the impact of a change in final demand of one or more sectors on the entire economy can be estimated. The objective is to identify those sectors with high impact on the whole economy (key sectors). The key sectors have greater potential to generate economic growth through backward and forward linkages, i.e. stimulate the growth of the rest of the economy. The Leontief inverse, $(I-A)^{-1}$, a matrix derived from the input-output table, is used to estimate the multiplier effect. An element of the Leontief inverse gives the direct and indirect requirements of intermediate inputs per unit of final demand. Technically, the ij element of the Leontief inverse is denoted by the input-output multiplier (IO multiplier), M_{ij}. Key sectors are characterized by high IO multipliers; i.e. an increase in exogenous demand for a key sector induces high additional production in the total economy.

3.3. Extension of input-output analysis

We are interested in comparing the roles of subsectors corresponding to project work and subsectors with non-project work. Therefore, we extend the Leontief model by further separating each economic sector according to the share of project work (m = 1) and non-project work (m = 0). For instance, the sector "information and communication" accounts for 15.5% of German gross value added (GVA), of which 37.7% is generated by project work (subsector m = 1) and 62.3% by non-project work (subsector m = 0) (see Table 1).

Let s = 1, ..., n denote the index of economic sectors, m = 0 denote economic subsectors of non-project work, and m = 1 denote economic subsectors of project work. Furthermore, let X_s denote the total production value of an economic sector, while X_{sm} denotes the production value of the subsector of sector s that is managed by work organization m (project or non-project). We further assume that each subsector sm has a specific Leontief production function corresponding to a vector of input coefficients, $A^m = (a^m ij)$, and an input coefficient for economic factors, f, including labor and capital inputs, $B^m = (b^m if)$. Thus, introducing subsectors corresponding to a specific work organization m for each economic sector implies that the total Leontief input-output system can be partitioned as follows:

$$\Delta X = \left[\Delta X^0, \Delta X^1\right] = (I-A)^{-1}\left[\Delta E^0, \Delta E^1\right] \tag{2}$$

$$A = \begin{bmatrix} A_{00} & A_{01} \\ A_{10} & A_{11} \end{bmatrix} \tag{3}$$

The partitioned input-output system comprises 2n subsectors. Let k = 1,..,2n denote the index of subsectors. For notational convenience, we assume in the following that subsectors are ordered in such a way that for each economic sector s, k = s denotes the non-project work subsector, while k = s + n denotes the corresponding project work subsector.

At the macro level, projectification corresponds to a structural change in the economy that has static and dynamic aspects. First, a structural change in the economy has an impact on static equilibrium outcomes, i.e. on production, employment and value-added. Applying IO theory, the economy-wide static impact of a change from non-project work to project work within an economic sector s can be derived from the shift in final demand from the subsector applying non-project work to the subsector applying project work. Hence, it follows:

$$\Delta X_k = \left[\Delta X_k^0, \Delta X_k^1\right] = (I-A)^{-1}\Delta E_s \tag{4}$$

$$\Delta E_s = [0, \ldots, \Delta E_s, \ldots, \ldots, \Delta E_{s+n}, \ldots 0] \text{ and } \Delta E_s + \Delta E_{s+n} = 0 \tag{5}$$

The matrix $M = (I-A)^{-1}$ defines IO multipliers, where M_{ij} is an element of the matrix M and indicates how many additional units of a sector i must be produced assuming that the final demand of sector j is increased by one unit. Given the extended IO table, the matrix of IO multipliers can be partitioned into a submatrix M^0 and a submatrix M^1. The latter includes all IO multipliers assuming the final demand of sectors applying project work is increased, while the former includes corresponding IO multipliers assuming the final demand of sectors applying non-project work is increased.

Furthermore, we can calculate the corresponding impact on factor demand (ΔF) and total income (ΔI):

$$\Delta F = \left[\Delta F_f\right] = B\,\Delta X_k \tag{6}$$

$$\Delta I = \sum_f \Delta F_f \tag{7}$$

Please note further that the change in production for a specific subsector k induced by a shift of final demand from non-project work to project work of a sector s results from the difference of the corresponding IO multipliers:

$$\Delta X_{ks} = \left(M^1_{k(s+n)} - M^0_{ks}\right) \quad (8)$$

Accordingly, the induced change in total production of a sector s' results from the sum of induced production changes in the corresponding subsectors:

$$\Delta X_{ks'} = \sum_{m=0,1} \Delta X_{(s'+mn)s} = \sum_{m=0,1} \left(M^1_{(s'+mn)(s+n)} - M^0_{(s'+mn)s}\right) \quad (9)$$

The impact of increased project work for a sector s can have a contrasting impact on the production of subsectors within another sector s'. For example, an increase in project work in the manufacturing sector can induce an increase in production in the project work subsector of construction while having a negative impact on production in the non-project work subsector of construction. Hence, the impact on total production is generally ambiguous, and the specific impacts observed empirically for a given economy depend on the interlinkages among sectors and subsectors.

However, projectification also has dynamic effects because it impacts technical progress and innovation. At the firm level, the literature has shown not only that innovation activities are often carried out in the form of projects (Müller et al., 2012; Gemünden et al., 2018) but also that project work can make firms more innovative (Manning, 2017; Spanuth and Wald, 2017). Directly measuring innovativeness at the macroeconomic level is difficult. However, induced changes in production can be used as a proxy for innovativeness, as the distinct types of innovation (product, process, organizational, marketing) have been shown to increase productivity (Griffith et al., 2006; Mohnen and Hall, 2013). Both project work and repetitive operations in permanent organizations can be considered technologies that transform a fixed set of inputs into a variable volume of outputs. Projects lead to a higher volume of production either due to product and service innovations (triggering a higher demand) or process and organizational innovation (improved efficiency due to technical progress and thus a higher volume of production from the same input).

To identify the macroeconomic effects of projectification, we simulate dynamic sectoral production effects implied by an increase in project work. Formally, innovation or technical progress induces an increase in future final demand via reduced unit cost or via increased quality of commodities. Moreover, the induced increase in final demand triggers spillover effects on all other sectors of the economy as described above. To simplify our analyses, we capture the final demand response induced by a given technical progress (TP) rate by a constant TP-demand-elasticity. The latter is defined as the percentage increase in final demand induced by 1% sectoral TP. Thus, the total dynamic economic impact of TP realized in a specific sector or subsector results from the induced shift in future final demand multiplied by the corresponding IO multipliers. Accordingly, the larger the TP of a sector, the larger the final demand response, and the higher the IO multipliers of a sector or subsector, ceteris paribus, the higher the dynamic macroeconomic effect of this sector or subsector. If the realized TP is higher in the project work subsector than in the non-project work subsector, shifting resources from the latter to the former implies at the margin a positive change in the induced increase in future demand. However, this relationship holds only if the TP-elasticities of the corresponding project work and non-project work subsectors are sufficiently equal. TP-elasticities depend on demand and supply responses. As we have no empirical information on TP-elasticities, we assume the same elasticity for all sectors and subsectors. This assumption allows us to focus our analyses of dynamic effects on (a) the relative TP rates realized in the different P and NP subsectors and (b) the economic interlinkages between sectors and between subsectors.

Hence, within our IOM, we calculate the final demand increase induced by sector-specific innovations, assuming a TP-elasticity value of 1 for all commodities and subsectors. Furthermore, let tp_s denote the relation between TP in the P and TP in the NP subsectors for sector s, respectively, while tp_0 denotes the base run technical progress for all non-project work subsectors. Accordingly, the dynamic impact of projectification on total production results as the annual total growth in production units is defined by the following:

$$\Delta X_s = \left[\Delta X^0_s, \Delta X^1_s\right] = (I - A)^{-1} \Delta E_s \quad (10)$$

$$\Delta E_s = \left[0, \ldots, tp_0\, \Delta E^0_s, \ldots, tp_s\, tp_0 \Delta E^1_s, \ldots 0\right] \text{ and } \Delta E^0_s + \Delta E^1_s = 0 \quad (11)$$

Furthermore, we set $tp_0 = 1$ for all sectors, which roughly corresponds to the average technical progress observed for the German economy in the last decade. Under these assumptions, the dynamic effects of projectification on production, employment and income can be calculated based on Eq. (10) and Eq. (11) as well as Eq. (6).and Eq. (9) Dynamic effects are expressed in unit changes per year. Thus, in contrast to static effects, dynamic effects continue and develop over time.

3.4. Empirical specification of the extended input-output model for Germany

To derive an extended IOM for Germany, we start with a standard IO table published by the Federal Statistical Office of Germany for the year 2011. The original IO table includes 72 economic sectors. Furthermore, final demand is separated into consumption of private and public households, investments and exports, while value-added is subdivided into labor and capital income. For our analyses, the original 72 economic sectors are aggregated into 10 sectors corresponding to the international economic accounting nomenclature as shown in Table 1.

Based on the aggregated 10-sector IO table, we derive an extended IO table separating each economic sector into two subsectors corresponding to non-project work and project work using the data of Wald et al. (2015). We calculate the average share of project work in the total production value for each of the 10 economic sectors. Let p_s denote this share for sector s; then for each economic sector s = 1,..,10, the production value of the project work and non-project work subsectors can be calculated as follows:

$$X_s^{*1} = p_s X_s; X_s^{*0} = (1-p_s)X_s \quad (12)$$

Moreover, based on the original IO table and the data of Wald et al. (2015), the cost structure for the project work subsector and the non-project work subsector are estimated for each economic sector s. Using these calculated input coefficients as prior values, i.e. $\overline{A} = (\overline{a}_{ij}); \overline{B} = (\overline{b}_{fj})$, we apply a Bayesian estimation procedure to estimate a consistent set of input coefficients of the extended IO table, (A,B), that generates the empirically observed sectoral production values, X* (see Heckelei et al., 2008):

$$(A, B) = argmin \sum_j \sum_i \left[\frac{(a_{ij}-\overline{a}_{ij})}{\overline{a}_{ij}}\right]^2 + \sum_f \left[\frac{(b_{fj}-\overline{b}_{fj})}{\overline{b}_{fj}}\right]^2 \quad (13)$$

$$s.t.[A\ B]\begin{bmatrix} X^* \\ F^* \end{bmatrix} = \begin{bmatrix} X^* \\ F^* \end{bmatrix} \sum_i a_{ij} + \sum_f b_{fj} = 1, \forall j$$

The estimated extended IO coefficients are presented in Appendix Table A1.

Based on the estimated IO coefficients, we calculate the matrix of extended IO multipliers. This matrix is used to simulate the economy-wide effects of project work on total production, employment and income. To calculate the dynamic effects of projectification, we follow the approach outlined above to derive for each economic sector the relative rates of technical progress for the project work and non-project work subsectors. Moreover, we calculate backward and forward linkages to identify key sectors, i.e. sectors that are characterized by input and output interlinkages above the average linkages of all sectors.

4. Results

4.1. Backward and forward linkages and key sectors

We first analyze the interdependencies between economic sectors by comparing the size of their IO multipliers to that of the average IO multiplier of all sectors. Key economic sectors are those sectors that are highly dependent on inputs from other sectors (backward linkage) and those sectors whose inputs other sectors are highly dependent on (forward linkage).

The forward linkage of a sector i, FL_i, is defined as the average IO multiplier M_{ji} across all sectors in relation to the average of all IO multipliers. It measures the relative importance of a sector as a supplier to other sectors (supply-driven effects):

$$FL_i = \frac{\sum_j M_{ji}}{\frac{1}{2n}\sum_k \sum_j M_{jk}} - 1 \quad (14)$$

A high forward linkage implies that a sector is important for other sectors in the sense that an increase in its final demand has a high impact on the production of all other sectors in the economy on average. Conversely, a backward linkage of a sector i, BL_i, is defined as the average IO multiplier M_{ij} across all sectors in relation to the average of all IO multipliers. It measures the relative importance of a sector as a demander (demand-driven effects):

$$BL_i = \frac{\sum_j M_{ij}}{\frac{1}{2n}\sum_k \sum_j M_{kj}} - 1 \quad (15)$$

A high backward linkage implies that a sector highly depends on other sectors in the sense that an increase in the final demand of a sector has a high impact on the production of this sector on average. Given the definition of forward and backward linkage coefficients, negative values imply linkages below average, while positive values imply linkages above average. Key sectors of an economy are defined as sectors with high forward and backward linkages. Fig. 2 presents the empirical results for the sector forward and backward linkages differentiating between the project work (P) and non-project work (NP) subsectors.

As shown in Fig. 2, the number and distribution of key sectors in the German economy differs between the P and NP subsectors. Among the NP subsectors of the economy, four sectors - manufacturing, retail, information and communication, and financial services - have high backward and forward linkages and thus are key sectors. Among the P subsectors, only manufacturing and retail are key sectors, and their backward and forward linkages are even higher than those for the NP subsector. These two sectors have a high share of total GVA and a very high share of project work (>40%). Information and communication and financial services are no longer key sectors when considering the project work subsectors. For information and communication, the forward linkages are close to the average of all sectors, and only the backward linkages are relatively high. For financial services, the forward linkages are below average, but the backward linkages remain high. Both information and communication and financial services have relatively small shares of GVA (4.6% and 4.7%) but different shares of project work (42% vs. 23%). Sectors with even lower shares of project work, i.e. agriculture (4%) and public services (17.8%), have backward and forward linkages that are still further below average when comparing the P subsector to the NP subsector.

To recapitulate, the relative importance of sectors as multipliers in the German economy differs significantly between the P and NP subsectors, although a few similarities exist. Wald et al. (2015) and Schoper et al. (2018) predicted a further increase in project work in Western economies. For the German economy, this may lead to a change in the structure of intersectoral interdependencies, as key sectors will change. Thus, projectification can change the relative importance of sectors for an economy.

4.2. Projectification and production effects/innovativeness

Within the IO model, static production effects resulting from an increase in project work for a sector can be estimated by

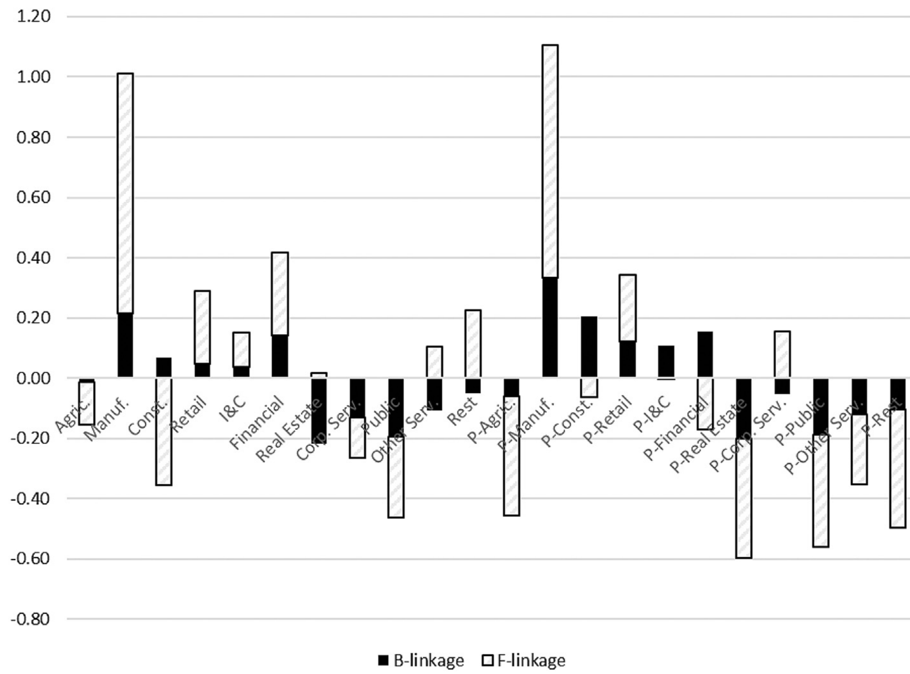

Fig. 2. Backward and forward linkages (own calculations).

subtracting the corresponding IO multipliers. Fig. 3 shows the production effects of projectification for the German economy.

The results show that an increase in project work significantly increases production at the level of the economy. The production effects are positive for the entire economy, but the results vary across sectors. For some of the key sectors identified in the section above - manufacturing, financial services, retail, information and communication - projectification implies large overall positive effects. Thus, in these sectors, shifting from non-project to project work increases production. The size of the key sectors' overall projectification implies a substantial increase in production given an average IO multiplier of almost 0.7; i.e. shifting one unit of final demand from non-project work to project work implies an increase in the total production value of 0.7 units.

As shown in Fig. 3, projectification has strong effects in the manufacturing sector. This sector includes many small- and medium-sized, highly innovative firms that are considered “hidden champions” in their respective markets (Venohr and Meyer, 2007; Simon, 2009). Manufacturing, like other sectors, is rather heterogenous and comprises several subsectors. For instance, it

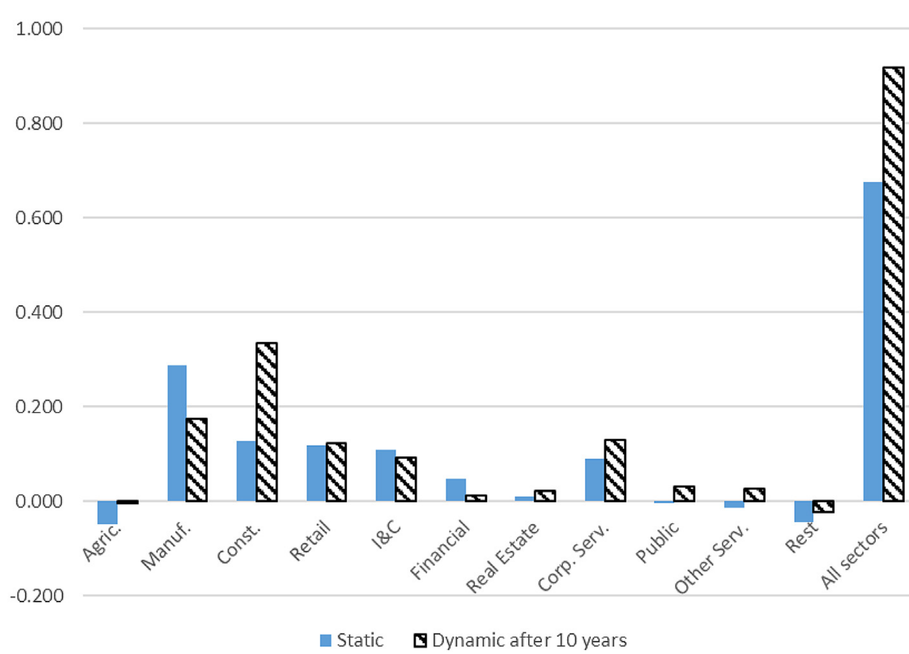

Fig. 3. Static and dynamic production effects of projectification.

includes plant engineering, where almost the entire production is organized as projects, and automotive, which features more process-based (repetitive) mass production. Even for the automotive, the manufacturing of goods only accounts for a small share of a firm's activities. The prevalent project types in the manufacturing sector are new product development projects (19%), commissioned external projects (24%), marketing/sales projects (16%), IT projects (14%), and HR projects (14%) (Schoper et al., 2018: 77). Thus, projects in this sector mostly pertain to administrative tasks and support functions but also include production (external projects). Firms choosing to use projects in marketing, new product development and information technology may develop more innovative products, sell them to their customers more efficiently, and improve internal processes and therefore increase production. Furthermore, projects are used to introduce flexible manufacturing systems that enable more customized production, such as additive manufacturing technology (Mellor et al., 2014). This flexibility renders production itself more project-oriented.

For agriculture, the public sector (static effects only) and other services (static effects only), projectification has a negative impact on production, i.e. reduces the innovativeness of the respective sectors. This finding contradicts research at the micro level which has found that the use of project work is related to innovation activities such as new product development (Müller et al., 2012; Gemünden et al., 2018). However, this finding also shows that micro-level results do not necessarily translate to the macro level. In particular, reorganizing specific sectors from non-project to more project work might induce negative static structural effects, even though projectification increases the innovativeness of these sectors. Interestingly, this is the case for the public sector and other services. As shown in Fig. 3, while static impacts are negative for these two sectors, the dynamic impacts of projectification are positive. That is, our empirical estimation implies that projectification induces higher technical progress in these two sectors. By contrast, for agriculture (as well as for "rest", which comprises the residual sectors), projectification has a negative impact on innovativeness; i.e. for these sectors, technical progress is lower for the project work subsector than for the non-project work subsector. Both the static effect and the dynamic effect are negative. On the other hand, for a project-based sector like construction, a further increase in the share of project work results in positive static and dynamic structural effects, i.e. induces an increase in production.

Overall, projectification has a significant positive impact on innovativeness, as the dynamic impact of projectification corresponds to an increase of 0.09 units of production per year. Thus, after roughly 6 years, the dynamic impact of projectification outweighs the static impact. The total production effect of projectification, including static and dynamic impacts, induced by a shift of one unit of final demand from non-project to project work amounts to 1.6 units within 10 years.

4.3. Projectification and employment

Schoper et al. (2018) provided empirical evidence for the prevalence of different project types and showed that projects are used for several reasons, e.g. creating infrastructure, new product development, creation of IT infrastructure, and organizational change. A common feature of most project types is that they are used for firm growth, which can be supposed to have positive effects on employment. However, as shown above, the static structural impact of projectification leads to overall productivity gains, which may reduce the need for workforce if dynamic effects are neglected. This pattern is in line with research on the relationship between innovation and employment arguing that innovation can have both employment-creating and employment-destroying effects (Vivarelli, 2014; Lim and Lee, 2018). Overall, there is no uniform expectation for employment effects of projectification.

As shown in Fig. 4, the overall static structural impact of projectification on employment is positive but very moderate.

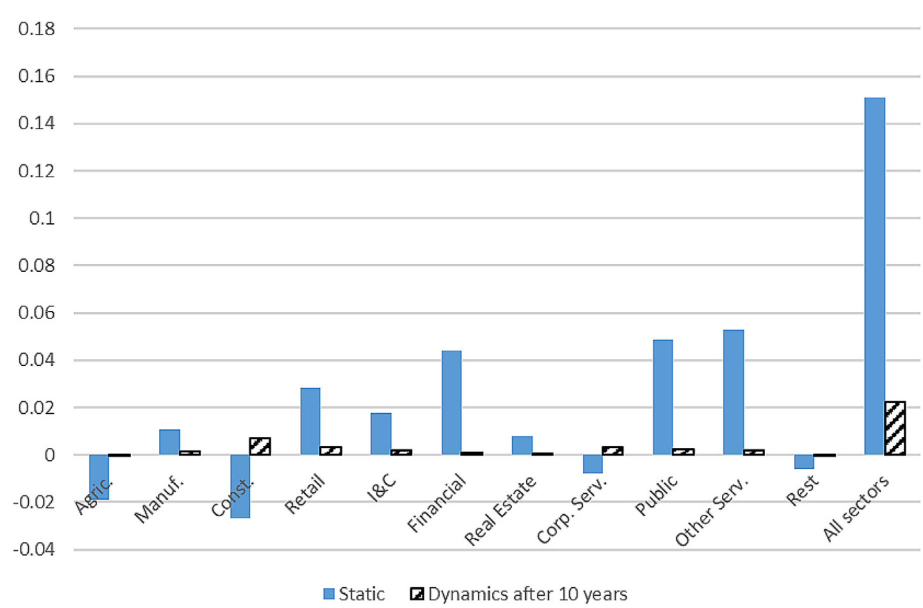

Fig. 4. Employment effects of projectification.

Shifting 1 unit of final demand from non-project work subsectors to project work subsectors increases employment by only 0.15 units. Neglecting dynamic effects for the moment, the assumption of both positive (growth and innovation) and negative effects (productivity and efficiency) is supported by the (static) employment effects in different sectors. In contrast to the (static) production effects, employment effects are relatively high for information and communication and the key sectors of retail and financial services and very small for manufacturing. They are comparatively high for the public sector and negative for corporate service providers.

Dynamically, projectification induces an increase in final demand, which in turn fosters employment. Accordingly, the dynamic impacts of projectification are positive for all sectors except agriculture and "rest", as projectification reduces innovativeness in the latter. Interestingly, especially for construction, relatively strong positive impacts of projectification on innovativeness can be found that overcompensate negative static structural impacts. Overall, projectification has significant positive effects in the long run; i.e. a shift of one unit of final demand from non-project to project work implies an increase in total employment of 0.02 units after 10 years.

4.4. Projectification and income effects

As a last step, we analyze the income effects of projectification. Within the extended IOM, the impact on total gross private household income can be calculated by multiplying the corresponding IO coefficients (b_{fj}) by the sectoral production effects induced by sectoral projectification. The results are presented in Fig. 5.

As shown in Fig. 5, the overall static effect of projectification on total factor incomes is positive but very small. Shifting one unit from non-project work to project work increases total gross factor income by 0.014 units. In addition, for key sectors (manufacturing, financial services and retail), projectification has only negligible effects on total factor income, with IO multipliers ranging from 0.0055 for manufacturing to 0.026 for financial services. These small effects clearly contrast with the strong production effects of projectification found for the key sectors. On the contrary, for public services as well as other services, the total static income effects of projectification are comparatively high, given the negative production effects found for these sectors.

In contrast to the static effects, the dynamic effects of projectification on income are significantly positive. The total dynamic effect corresponds to an increase of 0.28 units of total factor income per year.

5. Discussion and conclusion

5.1. Contribution to research

This study contributes to the burgeoning research on the prevalence and consequences of projectification (Lundin et al., 2015; Bakker et al., 2016) by providing the first empirical evidence of the macroeconomic effects of firm-level projectification. Existing research has focused either on the firm level (Hobday, 2000; Manning, 2017) or on the level of individual project workers and teams (Spanuth and Wald, 2017), but no research has considered the macroeconomic consequences of projectification. The first systematic measurement of projectification revealed that in the German economy, 34.7% of all work is carried out in the form of projects (as of 2013). More recent research (Schoper et al., 2018) found similar values for Norway (32.6%) and Iceland (27.7%), indicating that the share of project work in advanced Western economies seems to converge at approximately one third of total work. This significant share of project work can be supposed to have consequences at the sector level and on the economy for three reasons. First, project work is different from working in permanent organizations due to the characteristics of temporary organizations. Second, empirical

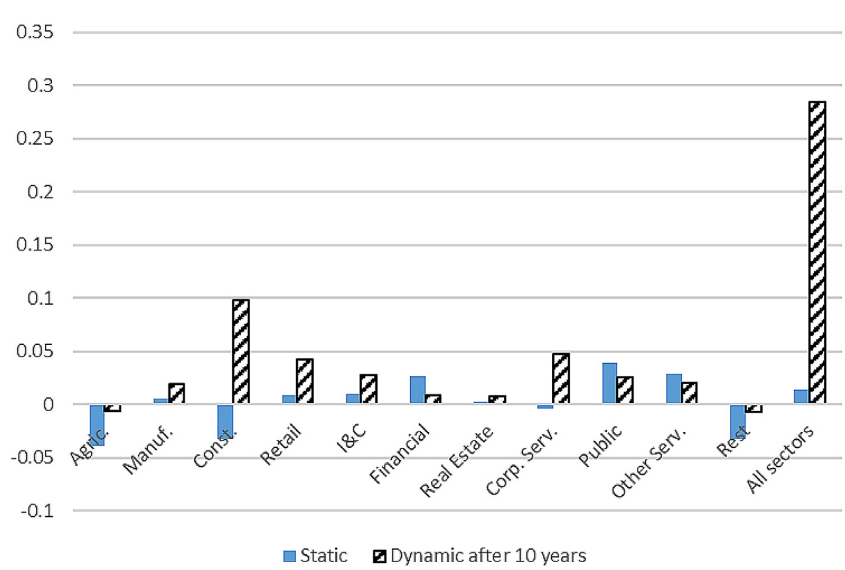

Fig. 5. Income effects of projectification.

studies at the level of firms and project teams have shown that project work can have several positive effects. Third, projectification constitutes an organizational innovation, and research has shown that organizational innovation can have positive effects on product innovation and firm performance (Sapprasert and Clausen, 2012; Cozzarin, 2017). These effects can be assumed to be cumulative at the level of sectors and the entire economy. We extended the standard IO analysis by differentiating between project work and non-project work subsectors and analyzing the interdependencies between sectors. Applying a Bayesian estimation procedure, we estimated an extended set of IO multipliers that we used to simulate static and dynamic effects of projectification on production/innovativeness, employment, and income. Our findings contribute to the literature in four main categories.

First, the differences between project work and non-project work are clearly visible at the macroeconomic level. The effects of projectification on sectors and the economy differ from those of non-project work. This is reflected by the divergent set of key sectors between the project work and non-project work subsectors and by the findings on the effects of projectification on production/innovativeness, employment, and income. At the individual, team, and firm levels, project work has been found to have specific characteristics that differ from those of ordinary work in the permanent organization (Bakker, 2010; Hanisch and Wald, 2014). Our results indicate that these characteristics also affect the macroeconomic level. The differences in the key sectors and in the induced changes in innovativeness and employment among sectors show that projectification leads to structural changes in the economy, i.e. changes in the relative importance of sectors regarding economic performance and intersectoral interdependencies. These structural changes have significant static and dynamic impacts on equilibrium outcomes, i.e. production, employment and income.

Second, the general assumption that projectification has positive effects on the economy is supported by empirical evidence. In particular, our empirical results indicate that projectification has a strong and positive overall impact. A shift of one unit of final demand from non-project to project work subsectors implies an increase of 1.6 units in total production, 0.4 units in employment and 0.3 units in income within 10 years. Overall, projectification not only appears to be increasing in Western economies but also has positive effects on the economy. The particularly strong effect on innovativeness suggests that projects represent an adequate form of organizing for innovation, which in turn is key for growth and competitiveness (OECD, 2005).

Third, our analyses indicate that the effects of projectification are heterogeneous across sectors, outcomes and time. In particular, static and dynamic effects can be distinguished. While strong and positive dynamic effects of projectification are found for almost all sectors in the German economy, the corresponding static structural effects of projectification are often much weaker and partly even negative. This is especially true for the effects of projectification on employment and income. For specific sectors, e.g. agriculture, an overall negative effect of projectification on economic outcomes is identified, while for others, e.g. public services, mixed effects are found, i.e. negative static but positive dynamic impacts. Hence, for the latter sectors, the overall effect crucially depends on the time horizon, with positive dynamic effects dominating negative static effects in the long run. For agriculture, increasing projectification reduces innovativeness, which leads to less employment and a decrease in income. Therefore, increasing use of projects as a temporary form of organizing cannot be recommended without reproach, and a 'wiser' form of projectification, i.e. an optimal mix of project and non-project work, must be found.

Fourth, we contribute to the scarce empirical research on the effects of organizational innovation on economic growth and performance at the sector and economy levels. As pointed out by Sapprasert and Clausen (2012), the lack of empirical data and measurement have largely prevented investigations of these relationships. We found that projectification as an important organizational innovation has positive effects at both levels.

5.2. Limitations and future research

To the best of our knowledge, this study is the first to investigate the macroeconomic effects of projectification. The case of the German economy illustrates that projectification can have major effects on sectors and the entire economy. However, our research has several limitations that need to be addressed by further studies.

To apply IO analysis for modeling the effects of projectification we had to make several assumptions as outlined in Section 3. Although this is an accepted approach in economic modeling, each of the assumption can be questioned regarding their plausibility.

Furthermore, we built on the survey data of Wald et al. (2015), who were the first to systematically measure the degree of projectification in an economy including all sectors. Although the data were collected using a large sample, they may be less reliable than data provided by national statistical offices, which are the usual basis for IO analysis. Furthermore, the data do not permit a more fine-grained analysis of sectors and subsectors, as they only include aggregated data for ten main sectors. For instance, manufacturing includes diverse subsectors such as food processing, machinery, and motor vehicles that we could not further differentiate. Moreover, the effects on economic outcomes could be further disaggregated in future studies. In particular, effects on employment might be further disaggregated by specific types of labor force, e.g. skilled and unskilled labor, while income effects could be further disaggregated by household types, e.g. low-, middle- and high-income households.

The study of only one country significantly reduces the generalizability of the results. As the largest European economy and the fourth largest economy globally (as measured by GDP, see UN Data, 2017), Germany may be representative of advanced Western economies whose competitiveness relies on technological leadership and innovativeness. However, no further inferences on the effects of projectification can be drawn, and we call for more research including emergent economies and developing countries. Data on a larger set of countries would also allow the effect of projectification on imports and exports and cross-country interdependencies to be calculated.

Further research should also analyze the effects of projectification on innovativeness and employment in conjunction with other current developments, such as digitalization. In this context, labor is supposed to become more knowledge-intensive. As a consequence, the associated productivity gain may create technological unemployment but also jobs for more skilled workers (Hirsch-Kreinsen, 2016; Castro Silva and Lima, 2017).

Finally, at a methodological level, the analysis might be further elaborated using general equilibrium models that take price effects into account to obtain a more realistic picture of the adjustment paths of the total economy. Moreover, projectification might be explicitly included as an endogenous variable in the model. Within such an extended model framework, it would be interesting to identify political and institutional framework conditions that induce an optimal path of projectification from an overall society perspective. In particular, it would be interesting to identify collective dilemmas in the form of mismatches between individual motives to choose project work at the firm level and the overall benefits resulting from this choice at the macro level.

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